$$\overline{S}_{mj}^{k} = S_{jj}^{k} + \sum_{\substack{n \in HelperSet(k,j) \\ n \neq m}} S_{nj}^{k} p_{nj}$$

The p_{nj} is the probability metric defined for pair of cells and is the probability that cell-n helping cell-j and is calculated using adaptive update over time as,

$$p_{nj} = \alpha p_{nj} + (1-\alpha)\left(\frac{\text{Sum Bandwidth Received from Cell-}n\text{ to Cell-}j}{\text{Sum Bandwidth Requested by Cell-}j\text{ to Cell-}n}\right)$$

For example, the IIR filter co-efficient can be alpha=0.01. From the above SINR measurements, the serving cell calculates egress control metric (EGM) for users. The egress control metric for user-k served by cell-j, requesting help from cell-m is,

$$EGM_{m,j}^{k} = \frac{w_j^k S_{mj}^k}{1 + \overline{S}_{mj}^k}$$

[0085] The serving cell can place a request for help with the helper cells along with the EGM A cell as a helper receive the requests and can arrange the requests in descending order and start giving out the help until the backhaul bandwidth is exhausted.

[0086] For egress control considering a K-cell scenario, as an example, there may be a cell-1 which is receiving requests from cells 2, 3, . . . N. In this scenario there may be K users per cell and the bandwidth for the kth user in jth cell is β_j^k. When the cell-1 is over-subscribed, the egress bandwidth control decision needs to be made. In sending the help request, the cells 2, 3, . . . , N also send the accumulated SINR at the serving cell without taking cell-1 into account. Let $S_{12}^k, S_{13}^k, \ldots, S_{1N}^k$ represent the accumulated SINR at cells 2, 3, . . . , N respectively (excluding the SINR of those users at cell-1). Let $S_{12}^k, S_{13}^k, \ldots, S_{1N}^k$ represent the SINR measured at cell-1 for the users in cell-2, cell-3, . . . , cell-N. Generally, S_{ij}^k represents the SINR seen at cell-i for kth user in cell-j. This measurement is done at the serving cell with the pilot symbols from the helper.

[0087] Another egress control algorithm is described below:

[0088] serving cell computes an egress control metric for its users, the metric computed by serving cell-j for the helper cell-1 is,

$$Metric_{1j}^{k} = \left(\frac{w_j^k S_{1j}^k}{1 + \overline{S}_{1j}^k}\right)$$

w_j^k is i the scheduling priority weight of the user-k served by j-th cell for j=2, 3, N; and

$$\overline{S}_{1j}^{k} = S_{jj}^{k} + \sum_{n \neq 1} S_{nj}^{k} p_{nj}$$

p_{nj} is the probability that cell-n helps cell-j. At the helper cell, when it receives all the help requests along with egress control metric, the cell orders the metric numbers in descending order and allocate egress bandwidth to the users (e.g., UEs) from top until the egress limit is met.

[0089] Computing p_{nj}

[0090] While requesting for help the cells send accumulated SINR omitting the helper cell of interest

$$\overline{S}_{mj}^{k} = S_{jj}^{k} + \sum_{\substack{n \in Helpers(k,j) \\ n \neq m}} S_{nj}^{k} p_{nj}$$

[0091] The cell-j computes the probability of receiving help from helper cell-m by adaptive update (e.g. in a TTI),

$$p_{nj} \leftarrow \alpha p_{nj} + (1-\alpha)\left(\frac{\text{Sum bandwidth received from cell-}n\text{ to cell-}j}{\text{Sum bandwidth requested from cell-}j\text{ by cell-}j}\right)$$

[0092] Where Alpha is the filtering constant and wherein Alpha is the filtering coefficient, can be a tunable parameter

[0093] The probability is calculated for cell-pair and $p_{nj} \neq p_{jn}$

[0094] Finally we will discuss two helper request methods that require egress control mechanism for sorting help requests at over-subscribed cells.

[0095] MAAS: In Multi-antenna aperture selection method, the serving cell selects the reception set for its users based on SINR thresholds. In certain deployments, some cells may get lot of help requests compared to other cells or in systems where egress bandwidth is constrained; all the requests may not be fulfilled. MAAS based request mechanism does not account for how the other cells are loaded in requesting for help. Hence, in MAAS mechanism, some cells may continuously send request for help from other cells but not get any help. Liquid MAAS is formulated as a mathematical optimization problem that makes optimal help requests by incorporating the bandwidth constraints such that total utility is maximized.

[0096] Quasi-time Liquid MAAS algorithm: An iterative solution to the Liquid MAAS problem is developed which involves multiple message exchange between the cells before convergence. Due to convergence issues of the iterative algorithm within a TTI, quasi-time-Liquid-MAAS is proposed where iterations are implemented across TTI's. In quasi-real-time implementation the help requests at a cell are not guaranteed to be within the egress limit and hence require an egress control mechanism to satisfy the requests.

[0097] In the Liquid-MAAS solution as discussed above there may be a distributed iterative algorithm with the following steps:

[0098] 1) cell broadcasts to its neighbors, a notion of an egress price

[0099] i. This measures how much of bandwidth requests it gets compared to what it can serve

[0100] 2) cell takes egress prices, and does antenna and aperture selection